DESCRIPTION

ELECTROSTATIC SPRAYING DEVICE

TECHNICAL FIELD

The present invention relates to an electrostatic device for personal use, and more particularly to a device for spraying a liquid composition by means of an electrostatic force.

BACKGROUND OF THE INVENTION

WO 03/072263 discloses an electrostatic spraying device having a removable cartridge with a reservoir containing a volume of a liquid composition. The device includes a plunger pump that displaces the liquid out of the reservoir and a nozzle for dispensing the liquid. The nozzle is provided with an emitter electrode which applies a high voltage to the composition being supplied from the reservoir to the nozzle, i.e., electrostatically charge the particles of the liquid composition for spraying the composition by the electrostatic force. The plunger pump disclosed in WO 03/077263 is provided at the rear end of the reservoir on opposite of the nozzle head, which adds an extra dimension to the overall volume of the removable cartridge, and therefore requires a corresponding larger space for the device to accommodate the cartridge. Consequently, when the cartridge is desired to be sufficiently compact to be easily carried with a person, the cartridge is realized only at an expense of reducing a liquid holding capacity of the reservoir. Thus, there remains a need for making the cartridge as compact

as possible, while enabling the cartridge or reservoir to hold a sufficient amount of the liquid composition.

None of the existing art provides all of the advantages and benefits of the present invention.

SUMMARY OF THE INVENTION

The present invention is directed to an improved electrostatic spraying device which is capable of giving an increased liquid containing volume to a removable cartridge, yet keeping the cartridge as compact as possible for enhanced handling performance. The device in accordance with the present invention is configured to electrostatically charge and dispense the liquid composition from a supply to a point of dispense, and includes an actuator, a high voltage generator to provide a high voltage, a power source to activate the actuator and the high voltage generator, a reservoir to contain the supply of the liquid composition, and a dispensing unit. The dispensing unit is provided to spray the liquid composition, and includes a suction pump which is located in immediate upstream relation with the reservoir for supplying the liquid composition from the reservoir, and which is mechanically connected to the actuator to be driven thereby. An emitter electrode is included in the dispensing unit to be electrically connected to the high voltage generator in order to electrostatically charge the liquid composition. Also included in the dispensing unit is a nozzle that is disposed at the point of dispense for spraying the liquid composition.

One characterizing feature of the present invention resides in that the dispensing unit includes a suction pump which is located in an immediate

upstream relation with the reservoir for supplying the liquid composition from the reservoir. The pump is mechanically connected to an actuator provided on the side of the device and is caused to operate thereby upon receiving the electric supply. Thus, the suction pump can be concentrated together with the emitter electrode, enabling a compact design. The reservoir is made deformable according to pressure and/or contents for efficient feeding of the liquid composition by the suction pump.

The pump may be in the form of a gear pump having a pair of gears one of which is formed with a joint for detachable driving connection with the actuator. The gear pump is of an inherently simple structure and contributes to making the pump itself compact. In this connection, the gear pump is incorporated as a pump unit which is shaped into a generally flat configuration. The gears are arranged within the thickness of the pump unit with respective rotation axes perpendicular to a plane of the pump unit. Formed in the pump unit is a horizontal channel extending within the thickness of the pump unit to define an inflow path of the liquid composition from the reservoir to the gear pump as well as an outflow path from the gear pump to the nozzle. Thus, the pump unit adds only a small thickness to the dispensing unit, contributing to making the whole cartridge compact.

The dispensing unit may additionally include a plug to be inserted into a fitment secured at the mouth of the reservoir, so that the reservoir and dispensing unit come into fluid communication. Various configurations of the plug and fitment are possible for providing a detachable or non-detachable connection between the dispensing unit and the reservoir. The reservoir may be shaped to have a planar configuration of an approximate segment of circle defined between

a chord and a circumference of an approximate circle which is greater than a circumference of a semicircle, and a mouth provided at the center of the chord. This way, the mouth is located at a position so that the distance from the mouth to any point of the circumference of the circle is approximately the same. Thus, the liquid composition can be smoothly sucked up by the pump, thereby minimizing an amount of unconsumed liquid composition.

The fitment may be provided with a valve which seals the reservoir in a non-use condition for protecting the liquid composition from leakage or deterioration by exposure to the atmosphere. For this purpose, the fitment is configured to be cooperative with the valve to establish a feed passage from the reservoir to the plug of the dispensing unit for feeding the liquid composition from within the reservoir to the dispensing unit. The valve is configured to open and close the feed passage depending upon the condition of the use of the reservoir.

The fitment is preferred to move relative to the plug between an interim position where the valve is kept closed and a ready-to-use position where the valve is actuated by the plug to open. The fitment is retained to the dispensing unit even at the interim position such that the reservoir can be presented as being integrated with the dispensing unit. With this consequence, the user is only required to move the fitment into the ready-to-use position when using the fresh liquid composition, without being bothered to attach the reservoir to the dispensing unit. To this end, the fitment is configured to have a first catch which comes into a latching engagement with the dispensing unit in the interim position, and a second catch which comes into a latching engagement with the dispensing unit in the ready-to-use position. Further, when the device is out of use for a relatively long period, the user can move the fitment back into the interim position

for protecting the liquid composition during the non-use period.

These and still other features, aspects, and advantages of the present invention will become more apparent from the following detailed explanation of the preferred embodiment when taken in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the invention, it is believed that the present invention will be better understood from the following description of preferred, nonlimiting embodiments and representations taken in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view of an electrostatic spraying device in accordance with a preferred embodiment of the present invention;

FIG. 2 is a vertical section of the device of FIG. 1;

FIG. 3 is a front view of the device of FIG. 1;

FIG. 4 is a side view of the above device;

FIG. 5 is an exploded perspective view of the above device;

FIGS. 6 to 8 are respectively exploded perspective views of a removable cartridge utilized in the above device;

FIG. 9 is a perspective view of the cartridge of FIG. 8 as viewed from the bottom;

FIG. 10 is a bottom view of the cartridge of FIG. 9;

FIG. 11 is a sectional view of the dispensing unit;

FIG. 12 is a section take along line X-X of FIG. 11;

FIG. 13 is a perspective view of a main body housing of the device;

FIG. 14 is a perspective view of a metal plate forming a part of the dispensing

unit;

FIG. 15 is a partial rear section showing an electrical connection between the dispensing unit and a voltage terminal provided on the side of the housing;

FIG. 16 is a partial vertical section showing the electrical connection between the dispensing unit and the voltage terminal;

FIG. 17 is an exploded perspective view of the housing of the device;

FIG. 18 is a perspective view of the device shown with a front shell of the housing removed;

FIG. 19 is an exploded perspective view illustrating a center frame of the housing, a motor and a high voltage generator mounted on the frame in accordance with the preferred embodiment of the present invention;

FIG. 20 is an exploded perspective view showing the motor and its associated parts accommodated within the housing in accordance with the preferred embodiment of the present invention;

FIG. 21 is a perspective view of the above device with the inner cover removed;

FIG. 22 is a perspective view of the above device shown with the cartridge and an inner cover removed;

FIG. 23 is a vertical section of the device corresponding to FIG. 22;

FIG. 24 is an exploded perspective view of parts forming a field electrode and associated parts of the above device;

FIG. 25 is a perspective view of the above device with an outer cover attached;

FIG. 26 is a vertical section of the above device with the outer cover attached;

FIG. 27 is a plan view of the cartridge;

FIG. 28 is a front view of a fitment attached to a reservoir of the cartridge;

FIG. 29 is a cross section taken along line X-X of FIG. 28;

FIG. 30 is a perspective view of a dispensing unit utilized in the above device in accordance with a preferred embodiment of the present invention;

FIG. 31 is a side view of the dispensing unit of FIG. 30;

FIG. 32 is sectional view of the dispensing unit of FIG. 30;

FIG. 33 is a perspective view of a dispensing unit utilized in the above device in accordance with another preferred embodiment of the present invention;

FIG. 34 is a rear view of the dispensing unit of FIG. 33;

FIG. 35 is a side view of the dispensing unit of FIG. 33;

FIG. 36 is an exploded perspective view illustrating a switch, a selector, and associated parts of the device in accordance with a preferred embodiment of the present invention;

FIGS. 37A to 37C illustrate different positions of the selector, respectively;

FIGS. 38 and 39 are block diagrams respectively illustrating the operation of a spraying mode and a dripping mode given to the device;

FIGS. 40A to 40C illustrate different positions of a switch for making an analogous function of the selector in accordance with another preferred embodiment of the present invention;

FIG. 41 is an exploded perspective view of a cartridge in accordance with another preferred embodiment of the present invention;

FIG. 42 a perspective view of a reservoir forming the above cartridge;

FIG. 43 is a perspective view of a fitment secured to the reservoir for connection with a dispensing unit of the cartridge;

FIG. 44 is a perspective view of the fitment shown with a check valve taken away;

FIG. 45 is an exploded perspective view illustrating the check valve in association

with a plug of the dispensing unit;

FIG. 46 is a top view of the check valve;

FIG. 47 is a bottom view of the check valve;

FIG. 48 is an exploded perspective view of the cartridge;

FIG. 49 is a perspective view of the cartridge shown with the plug inserted into the fitment to a short extent to hold the fitment into an interim position of closing the check valve;

FIG. 50 is a perspective view of the cartridge shown with the plug inserted into the fitment to a full extent to hold the fitment into a ready-to-use position;

FIGS. 51A to 51C are respectively front, side, and sectional views of the dispensing unit shown with its plug inserted into the fitment to hold the fitment in the interim position;

FIGS. 52A to 52C are respectively front, side, and sectional views of the dispensing unit shown with its plug inserted into the fitment to hold the fitment in the ready-to-use position;

FIGS. 53A to 53C are respectively partial perspective and sectional views illustrating how the check valve is kept closed while the fitment is in the interim position; and

FIGS. 54A to 54C are respectively partial perspective and sectional views illustrating how the check valve is kept opened while the fitment is in the ready-to-use position.

DETAIL DESCRIPTION OF THE INVENTION

Now referring to FIGS. 1 to 7, there is shown an electrostatic spraying device in accordance with a preferred embodiment of the present invention.

The device is configured into a self-contained portable structure that is compact enough to be easily carried with. The device is basically composed of a main body housing **10** and a removable cartridge **200** containing a volume of a liquid composition to be electrostatically sprayed according to a mechanism already disclosed in WO 01/12336, WO 01/12335, US 2001-0020653A, US 2001-0038047A, US 2001-0020652A, US 2001-0023902A, and WO 03/072263, incorporated herein by reference. The liquid composition utilized in the device include those disclosed in WO 03/072263, also incorporated herein by reference, i.e., an emulsion having conductive and insulating phases, although not limited thereto.

The housing **10** is dimensioned to be grasped by a user's hand and incorporates an electric motor **30**, a high voltage generator **40**, and a battery **50**, i.e., a power source for activating the motor and the high voltage generator **40**. The motor **30** actuates a dispensing unit **220** provided on the side of the cartridge **200** to dispense the liquid composition, while the high voltage generator **40** applies a high voltage of 1000 volts or more to the liquid composition being dispensed for electrically spraying the liquid composition. The housing **10** is formed with a concavity **12** for receiving a reservoir **210** of the cartridge **200** containing the liquid composition. In a preferred embodiment, an inner cover **20** is detachably fitted over the upper end of the housing **10** to hold therebetween the dispensing unit **220** of the cartridge **200**. In another preferred embodiment, an outer cover **26** is detachably fitted over the inner cover **20** to conceal therebehind the dispensing unit **220** for protection thereof when the device is not in use.

In one preferred embodiment, the cartridge **200** is composed of the

reservoir **210** and the dispensing unit **220**. In another preferred embodiment not shown herein, the cartridge is made only of the reservoir.

The reservoir **210** may be suitably made of a plastic material which is deformable according to the contents of the liquid composition. The reservoir **210** may be made by the same resilient material, or combination of a rigid material and resilient material. An example of commercially available material suitable for providing the reservoir is the laminated film of VM-PET (Vacuum Metalised Polyethylene Terephthalate) having a thickness of 12 microns and LLDPE (Linear Low Density Polyethylene) having a thickness of 60 microns. Commercially available films are GLAE by Toppan for VM-PET, and FCS by Tocello for LLDPE. The reservoir may also be made of conductive material and being electrically connected to the high voltage generator so that the liquid composition therein is provided with more or less a common electric potential.

As best shown in FIGS. 6 to 9, in a preferred embodiment the dispensing unit **220** includes a pump **230** and a nozzle **240** which are integrated into a single structure. The pump **230** is a gear pump having a flat base **231** molded from a plastic material and formed with a plug **232** for detachable insertion into a fitment **212** secured to a mouth of the reservoir **210**. The pump **230** includes a metal plate **270** mounted in the base **231** of the molded plastic. The metal plate **270** is formed in its upper surface with a pump chamber receiving a pair of intermeshing gears **234**, an inflow channel **236** extending from within the plug **232** to the chamber, and an outflow channel **237** extending from the chamber to the nozzle **240**. The pump chamber as well as the channels **236** and **237** are sealed by an emitter electrode **250** secured between the base **231** and the nozzle **240**. The gears **234** are arranged to have their individual rotation axes extending

perpendicular to the plane of the base **231**, realizing a flat pump structure sufficient to be capable of being disposed between the reservoir **210** and the nozzle **240** only at a minimum extra dimension with respect to the height or length of the dispensing unit **220**. One of the gears **234** is coupled to a joint **238** projecting on the lower face of the base **231** for detachable driving connection with the motor **30** disposed within the housing **10**. As the gears are driven to rotate, the liquid composition is sucked up from the reservoir **210** through the inflow channel **236** and expelled through the outflow channel **237** to the nozzle **240**. Preferably, the nozzle **240** is molded from a compatible plastic material as the base **231** to have an internal nozzle pathway **242** extending from the bottom center to an apex **243**, as best shown in FIG. 2.

The emitter electrode **250** is disposed between the base **231** of the pump **230** and the bottom **241** of the nozzle **240** in order to apply the high voltage to and charge the liquid composition being dispensed through the nozzle **240**. In a preferred embodiment, the emitter electrode **250**, which is connected to receive the high voltage from the high voltage generator **40** in the housing **10**, includes a center antenna **251** and a coaxial cylinder **252**. The center antenna **251** extends into the nozzle pathway **242** to charge the liquid composition being dispensed in cooperation with the cylinder **252** that is provided to surround the nozzle pathway **242** to avoid the undesired corona discharging for suitable electrostatic spraying. The top end of the center antenna **251** is receded from the apex **243** of the nozzle **240** to give a sufficient insulation distance therebetween.

As best shown in FIGS. 13 to 16, the metal plate **270** is formed integrally with a pin **254** which projects through the base **231** for detachable electrical

connection with a voltage terminal **176** provided on the side of the housing **10** to relay the high voltage to the emitter electrode **250**. Turning back to FIGS. 6 and 7, the emitter electrode **250** also includes a flat bottom **253** that is placed over the base **231** to seal the pump. The flat bottom **253** and the metal plate **270** are cooperative to charge the liquid composition within the pump in order to avoid undesired current flow within the liquid composition in the pump which would otherwise cause deterioration of the liquid composition. As shown in FIGS. 11 and 12, the cylinder **252** is connected to the antenna **251** by a rim **255**. The rim **255** is formed with a plurality of slots **256** that communicate with the outflow channel **237** of the pump for passing the liquid composition from the pump to the nozzle pathway **242**.

As shown in FIG. 17, the housing **10** may be shaped into a generally flat disc, and thus basically composed of a center frame **100**, a front shell **120**, and a rear shell **140** all being molded from a dielectric plastic material and assembled together into a unitary structure to form a front compartment **130** and a rear compartment **150** on opposite faces of the frame **100**, respectively behind the front and rear shells. When taking such generally flat disc shape, the front compartment **130** accommodates therein the motor **30**, the battery **50**, and the high voltage generator **40** which are all supported on the frame **100**, while the rear compartment **150** constitutes the concavity **12** for receiving the reservoir **210**. The frame **100** is formed on its front face with individual sections **103**, **104**, and **105** respectively for mounting the motor **30**, the high voltage generator **40**, and the battery **50**, as shown in FIGS. 18 and 19. The motor **30** is received in the section **103** together with a gearbox **31**. The high voltage generator **40** is composed of a transformer **41** and various electric components mounted on a

printed board **80**. The transformer **41** is packed into an insulated module fitted in the section **104**. In that the transformer **41** occupies much more space than the motor **30** and battery **50**, the housing is designed to arrange the transformer **41**, the motor **30**, and the battery **50** in compact. That is, the transformer **41** is accommodated within the lower part of the front compartment, while the motor **30** and the battery **50** are accommodated within the upper part of the front compartment in side-by-side relation with each other such that the motor and the battery are arranged in stack with the transformer with respect to a vertical axis of the housing **10**. The section **105** receives, in addition to the battery **50**, a terminal fixture **52** having leads for electrical connection of the battery **50** to the motor **30** and the high voltage generator **40** through a power switch **60** and a control circuit formed on the printed board **80**. As shown in FIG. 20, the gearbox **31** includes a reduction gear set **32** through which the motor output is transmitted to an actuator **36** provided for detachable driving connection to the joint **238** of the pump **230** on the side of the cartridge **200**. Preferably, the actuator **36** is disposed immediately below a mount **110** formed at the upper end of the frame **100** and is accessible through an opening **112** in the mount **110**, as shown in FIGS. 22 and 23. The mount **110** is somewhat recessed for retaining the dispensing unit **220** thereon when the cartridge **200** is attached to the housing **10**. The mount **110** is cooperative with adjacent side walls **114** to define a positioning means for the cartridge. Preferably, a pair of hooks **108** is attached on the opposite sides of the frame **100** to constitute a positioning means for detachably holding the inner cover **20** on the housing **10**. The hook **108** has a release button **109** which releases the inner cover **20** upon being pressed. As seen in FIGS. 1 and 5, the inner cover **20** may have a flat top **21** formed with a center

window **22** through which the nozzle **240** projects when the inner cover **20** is placed over the top half of the housing **10** with the cartridge **200** attached to the housing **10**. The periphery of the window **22** constitutes a retainer ring that holds the flat nozzle bottom **241** on the mount **110** at the upper end of the housing **10**. As shown in FIG. 17, the front shell **120** is formed with a window **122** which communicates with the section **105** for replacement of the battery **50**. Thus, the battery **50** can be easily replaced by simply removing the inner cover **20** as well as a lid **124** of the window **122**. The lid **124** may be eliminated from the device for simplicity.

The rear compartment **150** may be accommodated with a field electrode which surrounds the reservoir **210** to give the same electrical potential to the liquid composition within the reservoir **210** and to the liquid composition within the dispensing unit **220** for keeping the entire liquid composition free from seeing the electric current which would certainly deteriorate the liquid composition.

As best shown in FIGS. 23 and 24, in one embodiment, the field electrode **170** is composed of a first plate **171** and a second plate **172** both made of an electrically conductive metal and shaped to define therebetween the concavity **12** surrounding the entire area of the reservoir **210**. The plates **171** and **172** are electrically connected to each other at their peripheries, and are secured to the frame **100** and the rear shell **140**. In order to receive the high voltage, the plate **171** is formed to have a lug **174** which extends through the dielectric plate **181** and the frame **100** for electrical connection with a terminal **44** of the high voltage generator **40**. The plate **171** is also formed with the voltage terminal **176** in the form of a spring catch for detachable connection with the pin **254** of the dispensing unit **220**, as explained hereinabove.

It is noted in this connection that the metal plate **270** and the **250** of the dispensing unit **220** are electrically connected to the field electrode **170** and therefore act as additional field electrode covering the pump. Also, the metal plate **270** is formed with a metal tube **271** which is inserted into the plug **232** to charge the liquid composition within the plug, and therefore acts also as a further field electrode. Thus, the liquid composition is electrically charged along the entire path from the reservoir **210** to the nozzle **240**. Instead of using the metal tube **271**, it is equally possible to provide an extension which extends from at least one of the plates **171** and **172** and projects outwardly from the concavity to cover the plug **232** and the adjacent part of the dispensing unit.

In a preferred embodiment, when the outer cover **26** is fitted over the housing **10**, as shown in FIGS. 25 and 26, a sealing rubber **27** at the inner upper end of the outer cover **26** comes into contact with the nozzle **240**. The outer cover **26** is also formed with tabs **28** one of which conceals therebehind the power switch **60** to keep the device inoperative. Also, the outer cover **26** conceals the release buttons **109** therebehind to prevent accidental detachment of the inner cover from the housing **10**.

With reference to FIGS. 27 to 29, the cartridge **200** is again explained in details with respect to geometrical configuration of the reservoir **210**. In one preferred embodiment, the reservoir as shown as **210,** is made from a deformable plastic material into a flat bag which has a planar configuration of a segment of an approximate circle and has a mouth to which the fitment **212** is attached. The fitment **212** is molded from a plastic material to have a socket **214** for receiving the plug **232** of the dispensing unit **220**. In detail, the reservoir **210** is shaped into the segment of circle defined between a chord and a

circumference of an approximate circle greater than a circumference of a semicircle. The mouth or the fitment **212** is located at a center of the chord such that the distance from the mouth to any point of the circumference of the circle can be made approximately the same, providing smooth sucking up of the liquid composition from the reservoir and deforming according to the amount of liquid composition left in the reservoir, such that residue left in the end can be kept to a minimum.

In one embodiment, the plug is detachable to the fitment via, for example, a resilient material provided with the fitment. The so-called clean-click-system fitment may be employed for realizing this embodiment. This embodiment is advantageous for providing a cartridge devoid of the dispensing unit, thereby providing an even smaller cartridge.

In the illustrated embodiment of FIG. 25, the fitment **212** is molded to give a first section **215** for welding connection with the reservoir **210** and a second section **216** for welding connection with the plug **232**. The first and second sections are molded from different plastic materials so as to be compatible respectively with different plastic materials forming the reservoir **210** and the plug **232**, according to their specific requirements. This embodiment is advantageous for providing a secure connection between the dispensing unit and the reservoir.

Other embodiments are possible for providing a secure connection between the dispensing unit and the reservoir. The plug may be molded to give a section for welding connection with the fitment, the section being compatible with the fitment. Alternatively, the fitment and plug may be integrally molded to give a section for welding connection with the reservoir, the section being

compatible with the reservoir.

Referring to FIGS. 30 to 32, there is shown the dispensing unit **220** having the plug **232** detachable to the fitment **212** according to one embodiment of the present invention. The plug **232** is molded integrally with the base **231** to have a first section **261** and a second section **262**. The first section **261** is molded from a plastic material forming the base **231**, while the second section **262** is molded from a plastic material different from that of the base but compatible with the plastic material forming the fitment **212**. Thus, the second section **262** fits easily into the fitment **212** and welded thereto such as by the known ultrasonic welding for secured sealing connection to the reservoir.

FIGS. 32 to 35 show another dispensing unit **220** having the plug **232** which is integrally molded with the fitment **212**. The fitment **212** is inseparably fixed to the plug **232** and is molded from a plastic material compatible with the reservoir for enhanced welding connection of the fitment **212** to the reservoir.

Referring to FIG. 36, the power switch **60** preferably includes a switch knob **61** and a switch contact **62** disposed within a center cavity **126**. The switch knob **61** is held within the cavity **126** by means of a retainer ring **127** to be capable of being depressed against a spring bias, and energizes the motor **30** and the high voltage generator **40** upon being depressed. A light-emitting-diode (LED) **63** disposed in the cavity **126** is energized in response to the knob **61** being depressed to issue a light through a transparent cover **64** for indication of the operation. In a preferred embodiment, the device also includes a selector **70** for selecting one of three modes, i.e., a lock mode for disabling the operation, a spraying mode for enabling the liquid composition to be electrostatically sprayed, and a dripping mode for enabling the liquid composition to be dispensed

out of the nozzle without being electrostatically charged. The selector **70** includes a handle **71** which is rotatable around the ring **127** for selecting one of three positions, i.e., a lock position, a spraying position, and a dripping position, as shown in FIGS. 37A to 37C, respectively defining the above lock mode, the spraying mode, and the dripping mode. In the lock position of FIG. 37A, the handle **71** has its portion engaged with the switch knob **61** to prohibit it from being pressed, thereby disabling the operating of the pump as well as the high voltage generator. The selector **70** also includes tact switches **72** and **73** which are arranged on the printed board **80** to be actuated selectively depending upon the position of the handle **71**. In the spraying mode of FIG. 37B, the tact switch **72** is activated such that the pump **230** and the high voltage generator **40** are simultaneously activated upon the switch knob **61** being pressed. In the dripping mode of FIG. 37C, the tact switch **73** is activated such that only the pump **230** is activated upon the switch knob **61** being pressed. Although not clearly seen in the figures, the device may further include an indicator showing which one of the dripping and spraying modes is selected for easy confirmation by the user. Such indicator is preferred to be disposed around the selector handle **71**.

The above operation will be explained also with reference to FIGS. 38 and 39. When the tact switch **72** is turned on by the selector handle **71**, the pressing of the knob **61** energizes a voltage source **81**, a motor controller **82** and at the same time an oscillator **83** for the transformer **41**, thereby activating the motor **30** to operate the pump **230**, while applying the high voltage to charge the liquid composition. When, on the other hand, the tact switch **73** is turned on by the selector handle **71**, the pressing of the knob **61** energizes the voltage source **81**

and the motor controller **82** only for operating the pump without applying the high voltage to the liquid composition. Thus, the user can easily drip the liquid composition by simply manipulating the selector prior to initiating the electrostatic spraying, assuring enhanced convenience of handling the device. The voltage source **81**, the motor controller **82**, and the oscillator **83** are formed on the printed board **80**. Further, the device includes an indicator for indicating which one of the spraying mode and dripping mode is activated. The indicator includes an LED controller **84**, an LED oscillator **85**, and a LED **86**. When the spraying mode is selected at the selector **70**, the LED controller **84** acts to turn on the LED **86**, as shown in FIG. 38, in response to the knob **61** being pressed. When, on the other hand, the dripping mode is selected at the selector **70**, the LED controller **84** drives the LED oscillator **85** to turn on and off the LED **86** intermittently, as shown in FIG. 39, in response to the knob **61** being pressed, thereby providing different visual confirmation to the user for easy distinction between the spraying mode and the dripping mode.

FIGS. 40A to 40C illustrate another scheme of selecting the dripping mode and the spraying mode. In this modification, a tact switch **74** of press-responsive type is cooperative with the switch knob **61A** to constitute the power switch added with the function of the selector. That is, the tact switch **74** gives three positions, i.e., an off position of FIG. 40A, a spray mode position of FIG. 40B, and a drip mode position of FIG. 40C. In the off position, the switch **74** is not actuated to disable the operation of the pump as well as the high voltage generator. When the knob **61A** is pressed to a small extent to correspondingly depress the switch **74**, the spraying mode is selected to energize the pump **230** as well as the high voltage generator **40** for making the

electrostatic spraying of the liquid composition. Upon the knob **61A** being pressed to a further extent, the switch **74** is correspondingly depressed to select the dripping mode to activate only the pump **230** for dispensing the liquid composition without the electric charge. Thus, the user can easily select the mode by simply varying the pressure applied to the switch knob **61A**. Alternatively, the dripping mode and the spraying mode may be assigned respectively to the depression of the small extent and to that of the further extent.

FIG. 41 illustrates a cartridge in accordance with another preferred embodiment of the present invention which is equally utilized in the above electric spraying device. Like parts are designated by like reference numerals, and therefore no duplicate explanation is deemed necessary. The cartridge **200** is composed of a dispensing unit **220** and a reservoir **210** which are basically identical to those disclosed in the above embodiment except that the reservoir **210** is provided with a specifically configured fitment **300** and that the dispensing unit **220** has specific structures for latching engagement with the fitment **300**. The fitment **300** is additionally formed with a valve **330** which is configured to be opened for allowing the supply of the liquid composition from within the reservoir **210** to the dispensing unit **220** only when the reservoir **210** is fully secured to the dispensing unit **220**. Otherwise, the valve **330** is kept closed to seal the reservoir **210**.

The fitment **300** is designed to detachably receive a plug **280** of the dispensing unit **220** and to take one of two positions depending upon an insertion depth of the plug **280** into the fitment **300**. One is an interim position where the plug **280** is inserted to a short depth, as shown in FIGS. 49, 51, and 53, and the other is a ready-to-use position where the plug **280** is inserted to a full extent, as

shown in FIGS. 50, 52, and 54. As will be discussed in detail, the valve **330** is opened only at the ready-to-use position.

The fitment **300** includes a jacket **302** shaped to be fitted into the mouth of the reservoir **210** and a cylindrical barrel **304** extending through the jacket **302**. A bore **306** extends through the barrel **304** for detachably receiving the plug **280**. Formed around the bottom opening of the bore **306** is a circular rim **312** in the form of a flat fringe, and a recessed bevel **314** of which upper end merges into a ring **316** on the barrel **304**. The ring **316** is spaced from the bottom of the jacket **302** to leave therebetween an annular groove **313** for securing the valve **320** to the fitment **300**. The plug **280** is provided with an O-ring **285** for sealing contact with the barrel **304** of the fitment **300**.

The valve **330** is molded from a rubber material and includes a jacket **332** which is analogous in shape to the jacket **302** of the fitment **300** and is formed in its center with a socket **334** for receiving therein the barrel **304** projecting on the bottom of the fitment **300**, as shown in FIGS. 45, 53C and 54C. The socket **334** is surrounded by and closed at its bottom with a thin wall structure which defines an elastic valve membrane **336** capable of being deformed to be responsible for a valve function. The membrane **336** is formed in its circular bottom with four vents **338** which are evenly spaced circumferentially around the bottom of the socket **334** in correspondence with the recessed bevel **314** of the barrel **304**. The recessed bevel **314** is provided to leave a steep edge around the ring **316** such that the valve membrane **336** is given an origin of elastic deformation at that edge for limiting the zone of the elastic deformation to a portion only below the ring **316**. This is advantageous for opening and closing the valve membrane

336 at a short stroke, and therefore giving a sufficient sealing pressure to the membrane **336**.

Formed on the inner bottom of the membrane **336** is a cross-shaped projection **337** which comes into abutment against the lower end of the plug **280** when the plug **280** is fully inserted into the socket **334**. As shown in FIGS. 46 and 47, the vents **338** are staggered with respect to the individual arms of the cross-shaped projection **337** for establishing a feed passage leading from the vents **338** to inside of the plug **280** through the bottom open end of the barrel **304**, which will be explained later.

The socket **334** is formed at its upper end with an inwardly projecting lip **333** which is press-fitted into the groove **313** around the barrel **304** of the fitment **300** for securing the valve **330** to the fitment **300**. At this time, a pair of studs **305** projecting on the bottom of the fitment **300** fit snugly into a corresponding pair of holes **335** in the upper end of the valve **330** for exact alignment of the valve **330** to the fitment **300**. Thus, the valve **330** is easy to be secured to the fitment **300** by making the use of the resiliency given to the whole structure of the valve **330**. In this respect, the valve is preferred to be made from the rubber material, although it is not limited thereto.

Turning back to FIGS. 43 and 44, the fitment **300** is also formed on its upper end with a coupler **320** for detachable engagement with the dispensing unit **220**. The coupler **320** includes catch projections **322** formed at opposite ends of a yoke **321** upstanding from the jacket **302**, and includes catch recesses **324** formed in a portion of the barrel **304** projecting on the upper end of the jacket **302**. The catch projections **332** come into latching engagement respectively with hooks **282** depending from the dispensing unit **220**, when the plug **280** is

inserted by the short extent, as shown in FIGS. 49, 51, and 53, whereby the fitment **300** or the reservoir **210** is held in the interim position. When the plug **280** is inserted further to the full extent, as shown in FIGS. 50, 52, and 54, detents **284** formed on the plug **280** come into latching engagement respectively with catch recesses **324** to retain the fitment **300** in the ready-to-use position.

In the interim position, as shown in FIGS. 51 and 53, particularly FIG. 53C,the valve membrane **336** is held in its original condition where it is urged for pressed sealing contact with the rim **312** as being kept intact from the lower end of the plug **280**, thereby closing the lower open end of the barrel **304** and therefore disabling the supply of the liquid composition from within the reservoir **210** through the plug **280** to the dispensing unit **220**.

When the fitment **300** is held in the ready-to-use position, as best shown in FIGS. 52 and 54, particularly FIG. 54C, the plug **280** abuts against the cross-shaped projection **337** to elastically deform the membrane **336** to such an extent as to leave a clearance between the membrane **336** and the rim **312**, thereby communicating the lower open end of the barrel **304** with the vents **338** through the clearance to establish the feed passage leading from the vents **338** through the clearance and the lower open end of the barrel **304** into the plug **280**. Thus, the liquid composition is allowed to advance through the feed passage to the dispensing unit **220**, as indicated by dotted lines in FIGS. 54B and 54C, so as to be electrostatically sprayed therefrom. Since the vents **338** are formed in opposed relation to the recessed bevel **314**, the vents **338** can be brought into an open communication with the lower end of the barrel **304** as soon as the membrane **336** is deformed to leave the rim **312**. It is noted in this connection that the plug **280** is formed at its lower end with slits **287** which are diametrically

opposed and staggered with respect to the individual arms of the cross-shaped projection **337** in order to take the liquid composition into the plug **280** through the slits **287** without being interfered with the projection **337**. Since the slits **287** are staggered with respect to the arms of the cross-shaped projections **337**, the feed passage can be made smooth for feeding the liquid composition successfully through the valve membrane to the plug **280** of the dispensing unit **220**.

With the use of the fitment **300** with the valve **330**, the reservoir **210** can be sealed to keep the liquid composition free from being exposed to the atmosphere, prior to starting the liquid spray, thereby protecting the liquid composition from deterioration or leakage in a non-use condition. The sealing the liquid composition is desirous for reasons of that the composition may be solidified upon exposure to the atmosphere to clog the pump and that the composition may absorb water in the air to lose an optimum phase, detracting from an optimum spraying effect. Thus, the reservoir **210** with the fitment **300** can be presented as a replacement package sealing the composition.

Further, since the fitment **300** can be retained by the dispensing unit **220** at its interim position where the valve **330** is kept closed, the liquid composition can be still prevented from the deterioration or leakage even when reservoir **210** is retained to the dispensing unit **220**. This is particularly advantageous in that the reservoir or replacement reservoir can be presented in the form of being integrated with the dispensing unit **220** so that the user is simply required to push the fitment **300** into the read-to-use position when using the fresh reservoir. In addition, when the user refrains from using the device for a relatively long period, the user can move the fitment back into the interim position for protecting the

liquid composition during the non-use period. Further, when the reservoir **210** is provided as being coupled to the dispensing unit **220**, the plug **280** can be kept free from being contaminated with unwanted bacteria which would otherwise deteriorate the composition.

All documents cited in the detailed description of the Invention are, in relevant part, incorporated herein by reference; the citation of any document is not to be construed as an admission that it is prior art with respect to the present invention.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.